VALIDATION OF A CRASH SIMULATION OF A VERTICAL DROP TEST OF A B737 FUSELAGE SECTION

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An important aspect of crashworthiness research is the demonstration and validation of computational tools for accurate simulation of airframe structural response to crash impacts. In fact, the "validation of numerical simulations" was identified as one of five key technology shortfalls during the Workshop on Computational Methods for Crashworthiness [1] that was held at NASA Langley Research Center in 1992. Analytical codes have the potential to greatly speed up the crashworthy design process, to help certify seats and aircraft to dynamic crash loads, to predict seat and occupant response to impact with the probability of injury, and to evaluate numerous crash scenarios not economically feasible with full-scale crash testing. The FAA has conducted 30-ft/s vertical drop tests of two 10-ft. long B737 fuselage sections, one with an auxiliary fuel tank mounted beneath the floor and one with two different overhead bins and luggage [2]. These tests provide an invaluable opportunity to evaluate the capabilities of computational tools for crash simulation through analytical/experimental correlation. To perform this evaluation, a finite element model of the fuselage section was developed and simulations were executed using the nonlinear, explicit transient dynamic code, MSC.Dytran [3].

The initial finite element model was developed to represent the B737 fuselage section with the conformable auxiliary fuel tank. A crash simulation was executed and predictions of the structural deformation and floor-level acceleration responses were correlated with test data obtained from the 30-ft/s drop test [2]. A follow-on simulation was conducted to generate pre-test predictions of the fuselage and overhead bin responses during the second vertical drop test. An assessment of the accuracy of the pre-test predictions was made and model improvements were suggested. These modifications can be categorized into three groups: (1) changes in the contact surface definition, (2) changes in model features including material and inertial properties, and (3) changes in the model to achieve a more accurate physical representation of the problem. Several of the suggested modifications were implemented and the effects of the changes on model accuracy evaluated. The focus of this paper will be to describe the development of the finite element model, the correlation between pre-test simulation predictions and test data from the vertical drop test of the B737 fuselage section with overhead bins and luggage, and an evaluation of the suggested modifications on model accuracy.

References

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3. Anon., "MSC.DYTRAN User's Manual," MSC.Software Co., Los Angeles, CA, 2002.